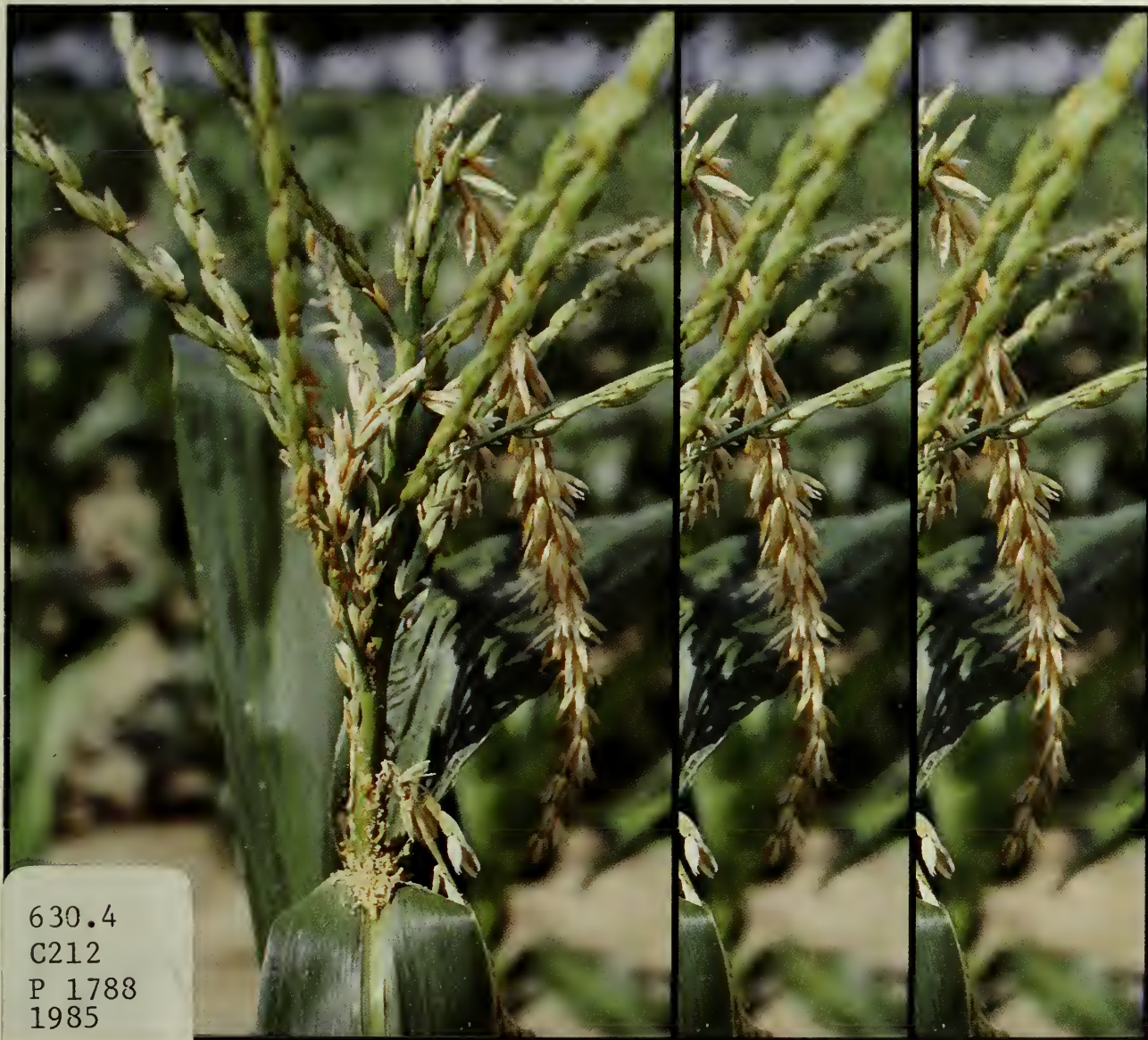


Insects damaging corn in Eastern Canada



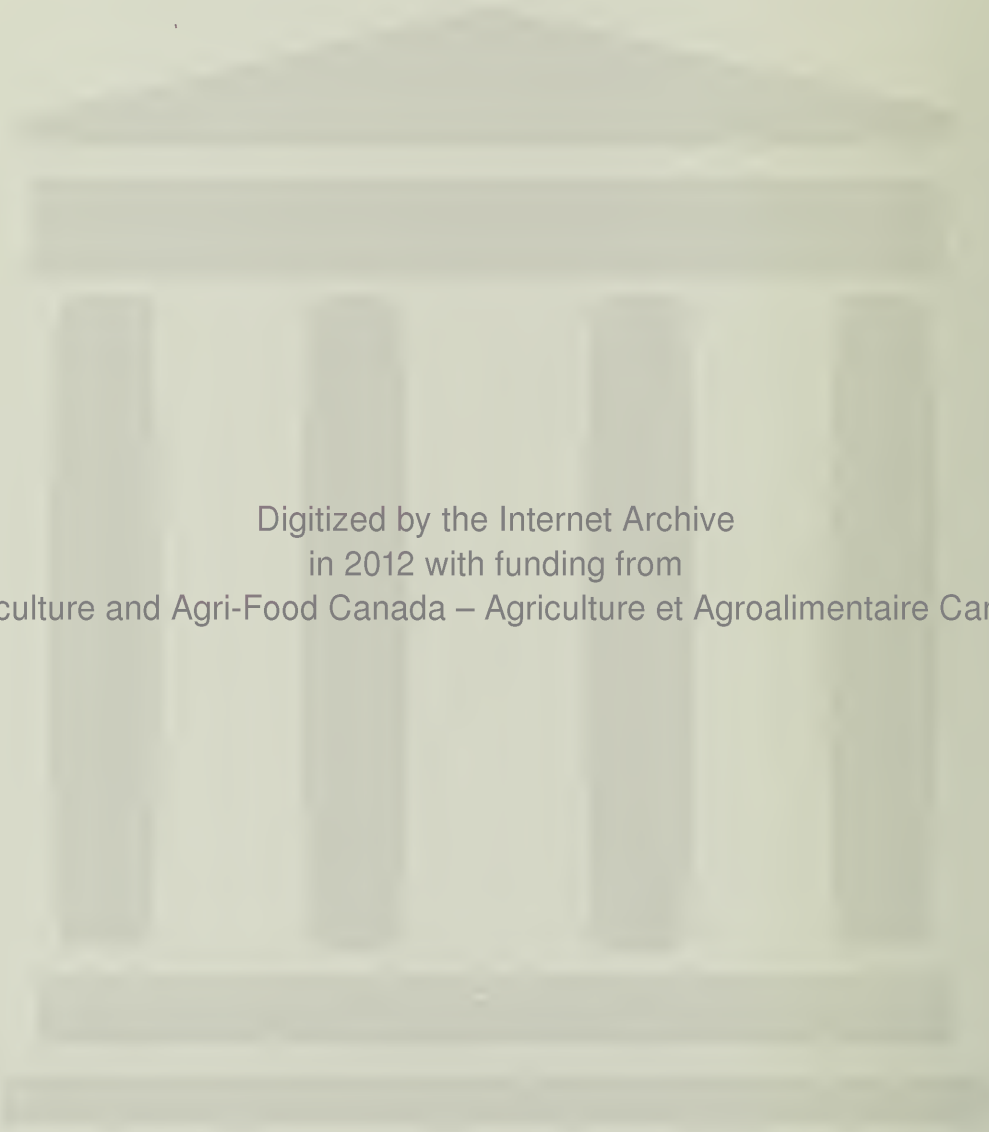
Agriculture
Canada

Publication 1788/E



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Insects damaging corn in Eastern Canada

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PUBLICATION 1788/E, available from
Communications Branch, Agriculture Canada,
Ottawa K1A 0C7

©Minister of Supply and Services Canada 1985
Cat. No. A43-1788/1985E ISBN: 0-662-13867-8
Printed 1985 5M-9:85

Également disponible en français sous le titre
Insectes nuisibles au maïs dans l'est du Canada.

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Recommendations for pesticide use in this publication are intended as guidelines only. Any application of a pesticide must be in accordance with directions printed on the product label of that pesticide as prescribed under the *Pest Control Products Act*. **Always read the label.** A pesticide should also be recommended by provincial authorities. Because recommendations for use may vary from province to province, your provincial agricultural representative should be consulted for specific advice.

INTRODUCTION

Corn is the third most important crop in the world after wheat and rice and remains one of the most important in Canada, especially in the East. Grain corn, forage corn, and sweet corn are grown on more than 1.5 million hectares and 75% of this crop area is concentrated in Ontario, while Quebec ranks second. Corn is grown for grain or forage, as a vegetable, or for industrial use.

Corn is attacked by many different species of insects, but the various types of corn do not require the same degree of protection against insect pests. Production of sweet corn for human consumption, fresh or canned, generally requires the use of insecticides. On the other hand, forage corn is usually harvested green for use as silage, so it is much less seriously affected by insects. Grain corn, by far the most common type, is also the most vulnerable to insect attack because it is harvested late in the season; however, its lower value as a commercial crop rarely justifies the use of insecticides.

All parts of the corn plant—roots, stalks, and foliage—can be attacked by insects. Methods of controlling insect pests are changing constantly, especially with the development of new control materials that are often more effective and less polluting than products previously used. Some species of insects can become resistant to certain kinds of insecticides, so that a product that is satisfactory when first recommended can become outdated soon afterward. When using an insecticide, always follow the manufacturer's directions carefully. It is preferable, however, to use other nonchemical methods of control, such as crop rotation or planting cultivars with some resistance, or at least tolerance for certain species of insects.

This publication gives a brief account of the main insect pests that attack corn, and describes their appearance, biology, and habitat, as well as the parts of the plant they attack. Only general control recommendations are given in this publication: for more specific controls, consult provincial and regional bulletins or pamphlets that appear annually.

UNDERGROUND FEEDERS

It is difficult to control underground feeders due to the environment in which they grow, because their habitat makes them almost inaccessible.

Often a grower is unaware of the presence of insects until they have become established in a field, but then the damage is done, or at least well advanced. By observing a few precautions, however, you can prevent much injury. For certain feeders, such as wireworms and seedcorn maggots, a proper seed dressing before planting is all that is necessary. Cutworms are harder to eradicate and the crop must be watched carefully so that treatment can be applied at the right time.

Cutworms

Although sporadic pests, cutworms can cause major damage to corn crops. In outbreak years they occur in all parts of Eastern Canada where corn is grown. In the adult stage, the insect is a dark colored moth; it attacks corn at the larval stage. Some species feed only on the foliage, but most of the approximately 20 known species eat through the stems anywhere from 3 cm below the soil surface to 30 cm above it (Fig. 1).

Cutworms comprise a number of species belonging to the Noctuidae family; however, most damage is caused by a few species, among which the black cutworm is the most common and harmful.

Although most aspects of the biology of the black cutworm are well known, there is some uncertainty as to how it overwinters. Some scientists believe that it overwinters as a larva, pupa, or adult, whereas others think that it migrates from the south as a moth. In the southernmost parts of Eastern Canada the black cutworm probably overwinters as a late-stage larva or a pupa, but a large part of the population is made up of migrating moths.

In the first three stages of its larval development, the insect feeds on the foliage. At this time, its presence is difficult to detect except by careful observation of the crops. Damage appears on the leaves as symmetrically arranged holes of varying sizes. Beginning at the fourth larval stage, the larvae feed only at night and burrow into the soil during the day. Entering the plant (usually at the crown), they tunnel their way upward inside the stalk. More than 90% of all damage is caused by larvae in the fourth, fifth, and sixth stages.

Corn plants less than 40 cm high are the most vulnerable to attack by black cutworms, but more mature plants are also infested.

Other types of cutworms occasionally attack corn crops. The larva of the dingy cutworm is brownish with a triangular mark on its back; it overwinters as a young larva and begins feeding early in the spring. During the summer it is not very active. The moths emerge and lay eggs in August and September.

The variegated cutworm and the spotted cutworm are two other potential pests of corn. The moths emerge in late May and lay eggs on the leaves and stems of plants. The larva of the variegated cutworm is easily identified by a characteristic marking like a shield on top of the end of its abdomen. The larvae live and feed on the plant during their first four stages and it is only during the last two larval stages that they sometimes hide at ground level in the daytime.

The glassy cutworm is another underground feeder that may destroy corn. It is greenish white and appears translucent, hence the name "glassy." The larva often causes a serious problem in corn planted on old pastureland.

Control

In practice, cutworm attacks are often not detected until the larvae have reached the fourth or fifth stage and damage becomes obvious. Control is then very difficult; as they mature, cutworms rapidly become tolerant to insecticides.



Fig. 1. Damage to young corn plants by cutworms.

Cutworms have many natural enemies, such as parasites and ground beetles, and birds also feed on them. To reduce the effects on these natural agents, insecticides should be applied only if necessary. A few cutworms in a field do not necessarily mean that there is an outbreak, but careful watch must be maintained. If insecticides are needed, follow the recommendations for your area.

Corn rootworms

Three species of rootworms attack corn: the southern corn rootworm, the northern corn rootworm, and the western corn rootworm.

The southern corn rootworm, also known as the spotted cucumber beetle, is widely distributed throughout southern Canada and has a large host range. The adult is a yellowish green beetle with 12 black spots on the wing covers. It is not a pest of economic importance on corn in Eastern Canada.

The northern corn rootworm is the most common species on corn in Eastern Canada. The adult beetles, which are uniformly pale green or yellowish green, appear in late July and are present until frost. They feed on fresh silks of corn, and on the pollen of corn and other plants. This does not always stop kernel development, because the silks keep growing until pollination occurs. However, sometimes all the silks are cut back into the ear, and when beetles are numerous pollination and germination may be so affected that ears are barren or bear only scattered kernels (Fig. 2).

The females lay their eggs in late summer and early fall in the soil at the base of corn plants. The eggs hatch the following spring and the white

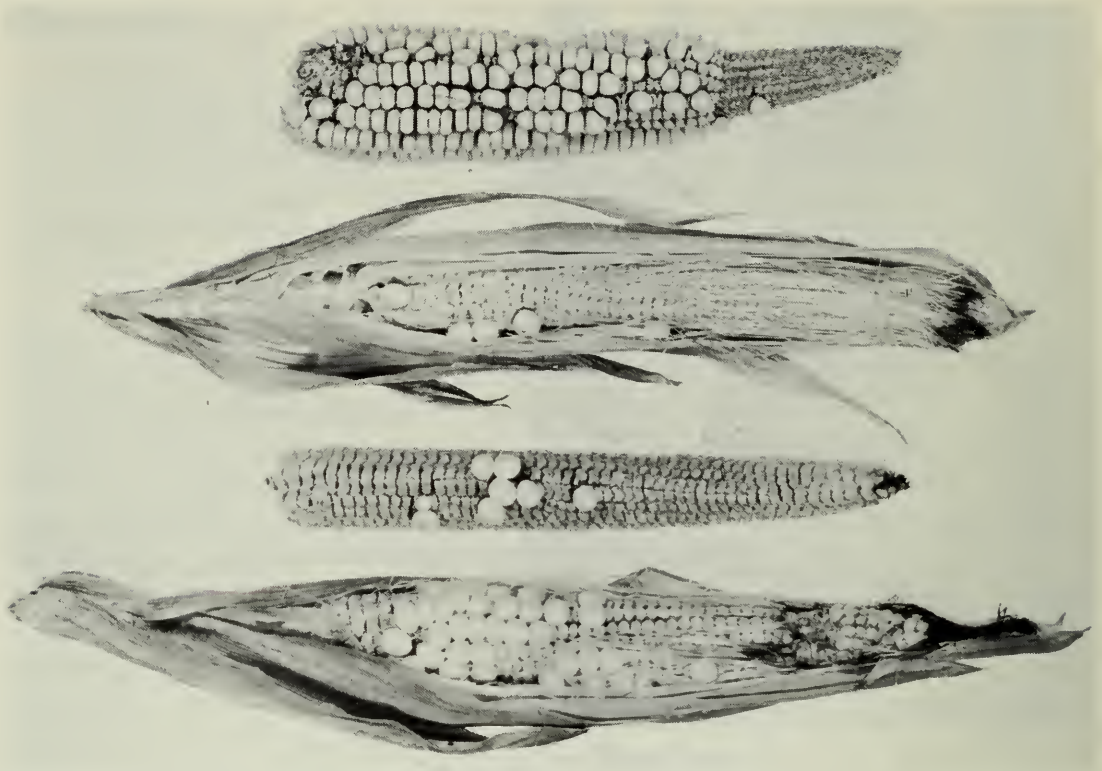


Fig. 2. Barren ears caused by poor germination, the result of corn rootworm beetles feeding on silks (*Courtesy Dr. J.P. Polivka, Wooster, Ohio*).

threadlike larvae (rootworms) feed on the roots of corn seedlings if corn has been planted again in the same field. The damage is often not noticed until after a heavy rainstorm, with strong winds, in July and early August. If the root system is much reduced by rootworm feeding, some plants may lie flat on the ground while others are badly lodged. In their efforts to straighten themselves many plants assume a peculiar bowed appearance. These are called goose-necked plants (Fig. 3). When the infestation is severe, the plants are so tangled that they are difficult to harvest. Many growers first become aware of the presence of rootworms when they see goose-necked plants, but controls cannot be applied at this stage.

The western corn rootworm did not occur in Canada until 1975 when small numbers were observed in Essex and Lambton counties in southwestern Ontario. Since that date there has been a gradual extension of its range to the northeast. It is now the predominant rootworm species in the southwestern counties of Ontario. The adult is yellowish green with black stripes and is slightly larger than the northern corn rootworm. The life cycle and type of damage it causes are similar to those of the northern species.

Control

So far as it is known, corn is the only important crop attacked by the northern and western corn rootworms. Consequently, significant damage occurs only when corn is grown on the same land in successive years (continuous corn).



Fig. 3. "Goose-necked" corn plants caused by early feeding of northern corn rootworm larvae. Note the small root system.

If you grow corn in rotation, no other control against the rootworm is necessary.

If you grow continuous corn, use one of the insecticides recommended in your provincial field crop recommendations. It should be applied at planting time in the year after you first notice goose-necked plants or badly damaged roots in the field.

White grubs (June beetles)

White grubs are the larvae of several species of June beetles. These beetles are found all across Canada but are most destructive in Ontario and Quebec. The grubs cause damage to corn by feeding on the roots.

The adults are large, brown, hard-shelled beetles which often fly to lights and lighted windows on warm evenings in spring and early summer. They feed on the foliage of many trees and shrubs and, if numerous, may cause severe defoliation. The pearly white eggs are laid in sod. These hatch in 2-3 weeks and the grubs usually feed for the next 3 years on roots of grasses, although a few species complete their life cycle in 1 year and others may take up to 4 years. Most damage is done during the second year. The grubs are white, with brown heads, curved bodies, and six prominent legs. The hind part of the abdomen usually appears darker because the soil particles inside show through the body wall.

White grubs are mainly a problem when corn is planted on newly broken grassland, particularly run-down fields or pastures. The 3-year cycle for these beetles is not uniform for all of Ontario and Quebec and must be determined separately for each area.

Control

To avoid damage, do not plant corn on land that has recently been in sod. However, if you must plant corn after sod, you can reduce damage by applying an insecticide to the soil before putting in the crop. Follow the recommendations or spray calendar for your area.

Wireworms (click beetles)

Adult wireworms, or click beetles, are 6–10 mm long and brownish black in color (Fig. 4). These insects, when laid on their backs, flip themselves over with a characteristic snap. Egg laying is always more abundant in native or cultivated grass or legume pastures, in cool or wet soil conditions. They are rare in annual cereal or field crops.

The larvae are commonly called wireworms because of their cylindrical shape and hard bodies. They are usually straw colored. The larval stage lasts 2–4 years, depending on the species. During this development, the larvae move vertically in the soil: in autumn, low temperatures make them burrow deep and in spring they return toward the surface. Wireworms attack the seeds and underground parts of the plants. They bore into corn seed and eat out the germ (Fig. 5), or enter the underground stem and kill the plant. This symptom is not apparent in mature plants but sometimes infested plants do not develop well and are less productive.

Fig. 4. Adult wireworm, or click beetle.



Fig. 5. Wireworm larvae in corn seed.



The most significant damage is caused by mature larvae and occurs in crops planted 2, 3, or 4 years after plowing under native or cultivated pastures, because larval development extends over several years.

Control

Because the eggs and larvae are fragile and easily harmed by dislodgement and dehydration, cultivation when the wireworms are present at shallow depths always causes high mortality. Thus, sod should be plowed under in summer. In the first year after pastureland has been plowed, it is recommended to select a crop resistant to wireworm damage or to use insecticides.

Before planting, always treat corn seed with an insecticide. A combination insecticide-fungicide treatment, as outlined in the provincial recommendations, will protect corn from wireworm injury. It is not recommended to plant corn the year after breaking sod, but in such an event, treat the crop according to local recommendations.

Seedcorn maggot

The adult of the seedcorn maggot is a small, grayish brown fly about 5 mm long (Fig. 6). It appears in the fields at about mid-May in southern Ontario and in late May in Quebec. Eggs are most commonly laid in moist soil where there is an abundance of decaying vegetation. The insect feeds on a wide variety of crops, including corn. The eggs hatch at temperatures as low as 10°C, and infestations are usually worse in cold, wet springs. The maggots (Fig. 7) feed inside the kernels, where they often destroy the germ or allow the entrance of soil organisms that rot the seed.

Fig. 6. Seedcorn maggot fly.



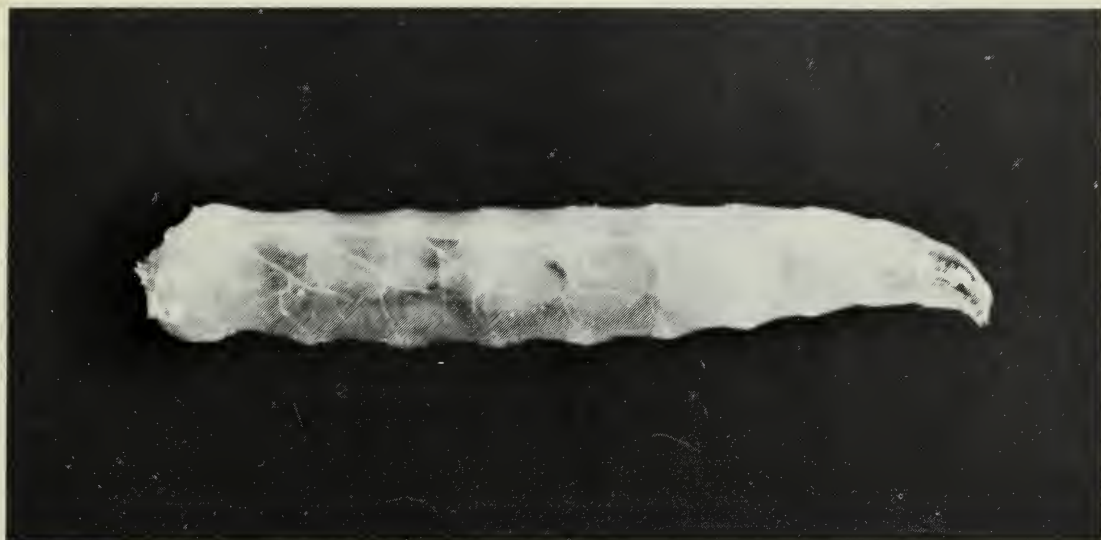


Fig. 7. Seedcorn maggot larva.

Control

If you grow a cover crop on land intended for corn, plow it under in the fall, or as late as practicable in the spring. Thorough incorporation of organic matter in the soil, preparation of the surface layers of the soil for rapid germination, and shallow planting will help to reduce damage since the fly is attracted by humus and moisture. *Treat all corn seed with a combination insecticide-fungicide before planting.* If you carefully follow the directions given in your provincial spray calendar or field crop recommendations, you will run little risk of maggot damage. If you do not treat seed and a maggot infestation occurs, you might need to replant the entire field.

Potato stem borer

The potato stem borer is a European pest introduced into Canada through the Maritime provinces early this century (Fig. 8). Since that time it has spread slowly westward, reaching Quebec several decades ago. In 1968, it was discovered in eastern Ontario and by 1972 it had reached western Ontario. In 1975, it was also seen in northern New York State. This insect remains scattered throughout the corn-growing areas of Eastern Canada. It is known to attack a wide variety of crop plants and weeds, but it still prefers corn to other economically important crops.

The first symptom of borer attack in a field is the presence of dead plants in the seedling stage, associated with a borer hole at or below ground level. Usually, a pinkish caterpillar can be found boring into the base of the plants or in the soil near them. Borer damage is easy to recognize; attacked plants turn brown from the tips of leaves downward, wilt rapidly, and break easily when pulled up. Seedlings 10–25 cm high collapse. Damage may vary from a few limited areas of a field to almost complete seedling kill. In a moderate infestation 20–40% of plants may be killed, but borer attacks fluctuate from year to year, depending on how weed-free the fields are kept.



Fig. 8. Potato stem borer and damage.

Brown, medium-sized moths emerge in early August. In September, eggs are laid in parallel rows on the leaf sheaths of weeds, particularly quack grass, growing in or around cultivated fields. Eggs hatch in May and the larvae start boring within the stems. By early June, the primary stems cannot support them any longer and the voracious caterpillars migrate to larger-stalked weeds and cultivated plants. The characteristic pink color of the larvae with darker bands across the body make them easy to distinguish. When mature, they measure about 4 cm long and they normally pupate in the soil at ground level in July. So far, only one generation per year has been observed.

Control

At present there is no satisfactory chemical method for control of this insect in corn fields. Numbers of potato stem borers may be reduced by keeping corn fields, borders, and fencerows weed free. The young caterpillars' habit of feeding on weeds and later moving to nearby corn plants makes it easier to control this insect, by improving weed control. Important weed hosts are the perennial grasses, particularly quack grass, which must be destroyed to prevent borer survival. Growers have noted in the past that weed control later than 1 May is less effective, because it makes borers on the weeds move sooner to corn plants.

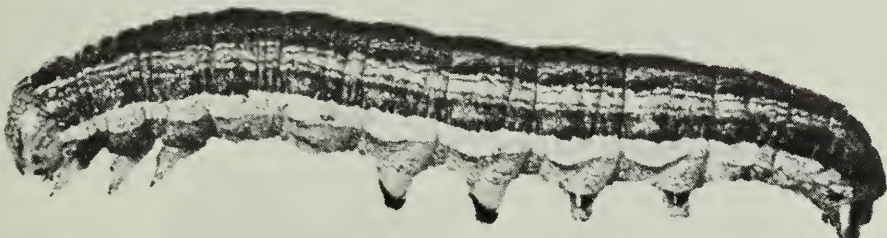
FOLIAGE, STALK, AND EAR FEEDERS

Armyworm

The armyworm is considered to be a native insect of North America. It is a species of cutworm that attacks a wide variety of crops but prefers corn, oats, wheat, and other members of the grass family. In Canada, it is widely distributed from the Atlantic to the Pacific coasts. Unless it is an outbreak year, the pest is usually held in check by its natural enemies: parasites (flies and wasps), predators (birds, toads, skunks, and ground beetles), and diseases. When favorable abiotic factors (number and size of storm fronts, which carry armyworm moths north in spring) prevail, armyworm outbreaks occur and natural enemies cannot cope with the situation. The most recent were observed in 1954 and 1964, with minor occurrences in 1972, 1978, and 1979. In some areas, particularly in the counties bordering Lake Erie where the main Canadian corn crop is produced, armyworms become numerous enough to cause serious economic crop losses.

The full-grown larva or caterpillar (Fig. 9) measures about 4 cm, is brown to dark green, and has five whitish longitudinal stripes on its body. Depending on geographical location, the larvae normally start appearing from late June to mid-July. They eat voraciously and grow rapidly to reach the most destructive life stage of the insect. They feed only at night, remaining hidden during the day in the center leaves of plants. When they have exhausted the food supply in a field, they migrate as an "army" to attack nearby fields when grain is ripe or hay is cut. This habit has given them their name. Larval maturity is attained within a month and they then cease feeding and transform themselves into cigar-shaped reddish brown pupae about 3 cm long. The pupae overwinter in the soil and emerge as adult moths. They are pale grayish brown with a wingspread of about 4 cm, the forewing having a distinctive white dot near the middle. After emerging from the soil in the spring, moths are seldom seen because they are active only at night, feeding on nectar, mating, and flying to find suitable sites for egg laying. Female moths lay their tiny white eggs in folded leaves or the leaf sheaths of grass, weeds, or small grains, or in hayfields and pastures. The eggs are laid in June and depending on prevailing temperatures, they hatch within 3 weeks.

Fig. 9. Full-grown armyworm, showing distinctive striping.



Corn can suffer severe damage compared with small grains or hay crops, the leaves often being completely eaten except for the midrib. Generally, the caterpillars are not noticed until crop damage becomes evident, in early July for southern Ontario and mid-July for the other corn-growing regions of Eastern Canada. By this time, they are at least half grown. Because the eggs are laid in dense vegetation, the young larvae are difficult to detect, feeding most of the time on leaves near the soil surface. There is no way to predict an outbreak of armyworms but they are easier to destroy if they are detected when still young. They are particularly abundant in areas of lodged grain or hay after a heavy rainstorm, so after such a storm growers should check corn in fields that border on such areas. The best time to look for armyworms is in the evening or early morning when caterpillars are feeding. Each year, armyworms are present in small numbers and most of the time, parasites and predators keep their numbers down so that there is no need to use an insecticide.

Control

Because of the wide publicity given to armyworm outbreaks, growers are often worried whenever these insects are found. Once an armyworm infestation has been detected, growers should determine its extent (whether throughout the field or only in the border rows), the size and number of caterpillars per square metre, the amount of actual damage to the crop, and the time remaining before harvest. Chemical control is not recommended when the caterpillars are nearly full grown, or parasitized larvae are found, and when the crop is near harvest; by that time, the damage has been done. When infestation is severe, insecticides are the only effective means of control. Usually, the few outside rows alongside hay, pasture, or grain fields are the only ones attacked. If armyworms have not moved into the corn, you need only treat the headlands of the adjacent fields and the first few rows of the corn field. Each field should be assessed and dealt with separately. The economic threshold warranting chemical control is when about 60 caterpillars per square metre are observed throughout a field. Insecticides are most effective when applied on warm evenings, before the caterpillars become active and when plants are dry. Treat the whole field if the caterpillars are scattered throughout. If only one section of the field is affected, treat only this section and a 10-m border around it to prevent the caterpillars from migrating to an adjacent area. Do not apply an insecticide except as a last resort. Armyworms will not move to a nearby field unless food becomes scarce or unpalatable.

If there are armyworms in a field next to your corn crop, use a poisoned-bran bait or one of the locally recommended sprays for control of cutworms. Before deciding to treat your crops, ask your agricultural representative or an entomologist for advice. You may save money this way. In many cases, insecticide treatment for corn borer control should take care of armyworms as well.

Fall armyworm

The fall armyworm was of little importance in the past but has suddenly become a more important insect pest in Eastern Canada. Farmers are becoming more and more familiar with the fall armyworm and the damage that it causes to late crops of sweet corn and forage corn. When fall armyworm populations are abnormally high in a field, the resulting severe defoliation to late-maturing corn causes much concern to growers. The ragged appearance of plants resulting from larval feeding makes a heavily infested field a disturbing sight. Normally, the insect overwinters only in the most southerly regions of the USA. Each year the moth flies northward by stages in the USA and occasionally it appears in Canada in late summer. Fall armyworm outbreaks rarely occur in Canada, but the insect may appear without warning wherever corn is grown. Its presence is normally associated with cool, wet weather. Such climatic conditions along the route of northward migration favor its rapid reproduction. In Eastern Canada, late-planted processing corn and field corn may be attacked in late August or early September, regardless of the weather.

Early damage by this insect is often missed, because the young caterpillars tend to feed deep within the leaf whorl. When damaged leaves unfold they have jagged edges and large holes (Fig. 10); the developing tassel may

Fig. 10. Damage by fall armyworm to corn in the whorl stage. Note the “shot” holes.



be severely damaged. On mature corn, larvae may feed on the ear shanks. Full-grown caterpillars are about 4 cm long and vary from light green to nearly black as they feed. They are marked with three pale yellow stripes down the back and by a darker line on each side, bordered with a wavy yellow stripe splotched with red. The fall armyworm has a white upside-down “Y” on the front of its dark brown head that distinguishes it from the corn earworm. The larva reaches maturity in 2–3 weeks and may be present for some weeks in a field.

Control

When leaf damage occurs on immature plants, crop loss is normally negligible, but it becomes progressively greater as the insects attack plants that are more mature. Corn plants can recover from severe leaf damage, depending upon the stage of plant growth when it occurs. Late-maturing corn is the usual target of fall armyworm attack and therefore an infestation is normally well advanced before it is detected; the larvae are then in a late stage of development within the leaf whorl and are difficult to reach with insecticides. Growers should check their fields for fall armyworm attack by mid-August. If damage is found, growers should consult an agricultural representative and possibly use an insecticide promptly. Control of the fall armyworm is normally not mentioned in provincial spray recommendation guides.

European corn borer

Since its introduction into Canada in 1920, the European corn borer has spread to all the major corn production areas and yearly losses are heavy. It is particularly destructive on sweet corn, because this crop is used for the fresh market and for processing (canning or freezing). The European corn borer is a serious problem on corn grown as a field crop. Both the one-generation strain, which occurs in most corn-growing areas of Eastern Canada, and the two-generation strain, which is found mainly in southwestern Ontario, can cause significant losses in yield of grain corn when moderate to severe infestations occur. Economic losses of corn grown for seed are especially important.

Fully grown larvae overwinter concealed in parts of the plants on which they have fed. They are flesh colored, about 3 cm long, and marked with brown spots (Fig. 11). They pupate in late spring and moths appear in June. The moths are buff colored with dark brown wavy bands across the wings; the male is smaller and darker than the female, with a less rounded end of the abdomen. Male and female moths with two newly laid egg masses are shown in Fig. 12. Although the first moths appear in the field in June, this varies with the year and place. Generally, egg laying begins at the end of June in southern Ontario, in early July in Quebec, and about mid-July in the Maritimes. Second-generation eggs are usually laid in early August, but laying can start in late July and extend to early September. Eggs are normally laid on the underside of the leaves of plants, often near the midrib, and the tallest maturing plants receive the heaviest infestation. Within 6 or 7 days,

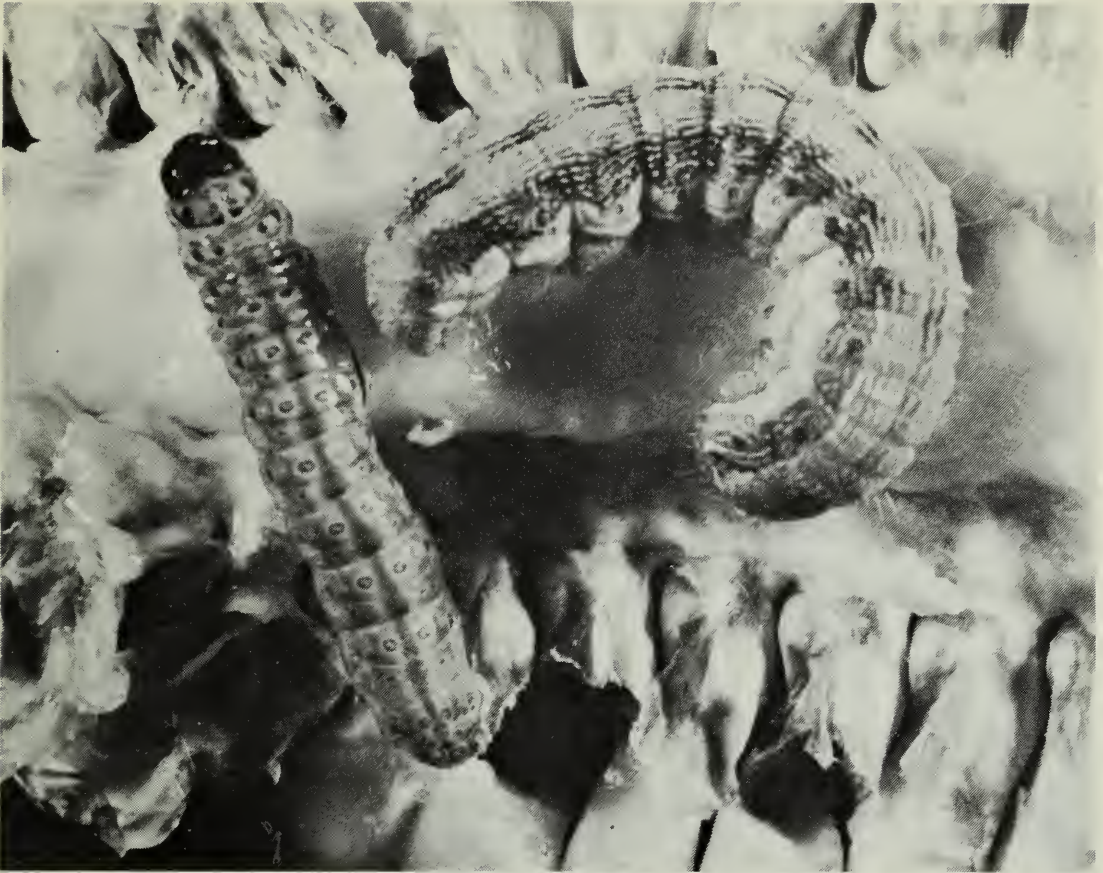


Fig. 11. Two insect pests of corn often mistaken for one another: European corn borer (left, spotted) and corn earworm (right, striped) (*Courtesy University of Guelph*).

depending on the temperature, the eggs hatch and the young borers start feeding on leaves in the whorl, causing damage to the opening tassel.

All parts of the plant are damaged by this insect. The first sign of its presence on plants is eating of leaves and midrib breakage. Young larvae feed on leaves for a few days, then migrate to the whorl part of the plant. They eat through the developing leaves that are tightly rolled up before they unfold. Some bore into the tassel, which weakens and later breaks in the wind. Some larvae eventually enter the developing ears, particularly of sweet corn. Maturing larvae tunnel through all parts of stalks and ears, which results in early breakage of tassels, heavy stalk breakage at harvest, poor ear development, and fallen ears. Cool, rainy weather during June and July reduces the infestation because it restricts egg laying and the tiny hatching borers are washed off the plants; also, very dry summers are unfavorable for development and survival. Cold winters do not seem to be very detrimental to borers, which can stand very low temperatures.

South of a line from Sarnia to London and Simcoe in southwestern Ontario there is a strain of corn borer with two generations per year, and often a partial third generation. Eggs of the first generation are commonly laid from early June to early July, but they have been found as early as 26 May and occasionally well into July. Larvae usually complete their growth before there is much ear development. Second-generation moths deposit eggs from late July to early September.

Fig. 12. European corn borer: female (left) and male (right) moths and newly laid egg masses.



Studies at the Harrow Research Station in Ontario have shown that the second generation always lays more eggs than the first and often causes a significantly greater reduction in yield of grain corn. The first generation causes mostly physiological damage, whereas second-generation infestations are responsible for both physiological damage and unharvestable ears because of damaged stalks and shanks. In sweet corn, infestations of larvae in ears are the major concern, regardless of which generation of borer attacks the crop. Not only are infested ears unsuited for sale as fresh-market produce, but small larvae may remain in kernels of sweet corn used for processing.

Control

Biological control agents (parasites, predaceous insects, and birds) have proved to be of little value in reducing borer populations, particularly when climatic conditions favor reproduction of the pest. Cultural practices still remain effective; plowing in the fall and disking in the spring can eliminate 75% of the overwintering larvae in a corn field. Shredding plant debris after harvest but before plowing the field, if carried out on a community-wide basis, is an economical and effective way to destroy borers hiding in stalks and stubble. Larvae in infested corn used as silage are killed by the silage cutter. Planting hybrid varieties of grain corn with resistance or tolerance for the first generation of borers, and adapted to your area, is recommended. Some varieties are better than others at resisting stalk breakage and ear dropping under light to moderate borer infestation, and are thus more easily harvested. No-tillage crop management favors survival and reproduction of borers.

In any area, the need for insecticide treatment is determined by the value of the crop and the severity of the infestation. Insecticides have to be applied at the correct time, which varies with locality. Always consult your agricultural representative for the recommendations that apply to your area. Early sweet corn for the fresh market or hybrid seed corn plantings require insecticide protection, normally three or four applications at 5-day intervals starting when the first eggs are hatching or leaf feeding is seen. Many insecticides are unfortunately highly toxic to bees and other useful insects, including the natural enemies of the borer. This is particularly the case when insecticides are applied from the air. Unless borer infestations in the one-generation areas become epidemic, grain corn seldom needs to be treated with insecticides, particularly when tolerant hybrids are grown.

The two-generation strain of corn borer presents different problems. In grain corn, moths of the first generation commonly lay more eggs on tall early-seeded plants, whereas those of the second generation lay more eggs on the younger, more vigorous late-seeded plants. To reduce damage by the first generation, grow resistant hybrids. To minimize damage by the second generation, plant the crop as early as feasible to reduce the amount of egg laying, and harvest it as soon as moisture content is acceptable. The latter recommendation is very important, because autumn storms can blow plants down and cause additional ear loss when there are numerous borer-damaged stalks and shanks.

Corn earworm

The corn earworm, a native of North America, is a southern species that normally attacks corn in Canada after midsummer. The large yellowish brown moths fly into Canada each spring from the southern USA where they overwinter. Moths normally fly at dusk but may also be active on warm cloudy days. The pale green eggs are laid singly on fresh silk and occasionally on the husks of developing ears. Within 3 days, the eggs hatch. The young caterpillars first feed on the silks and eventually work their way down to the kernels. Unlike the corn borer, they do not burrow into the kernels but eat them completely (Fig. 11).

The full-grown larva measures about 4 cm and varies in color from light green through brown to almost black. The head is yellow, the legs are almost black, and alternate light and dark stripes run lengthwise along the body which is lighter on the underside. In this, it differs from the corn borer larva which is spotted. Because of its large size and its voracious habits, a single caterpillar can attack the whole tip of the ear, devouring the kernels and fouling them with excrement, sometimes destroying the silks before pollination has been completed. The caterpillar may enter the ear from the side, but most of the time it works its way down from the tip. Thus, damage is often overlooked because the husk is rarely holed. The larval stage lasts about a month and when larvae are mature, they drop to the ground and burrow into the soil. Fortunately for corn production, the corn earworm is rather rare because it cannot overwinter in Canada, and it is not considered an annual insect pest.

Late-maturing corn can sustain severe damage from the earworm, but usually the sweet corn canning industry does not consider it to be as serious a pest as the corn borer. Earworms on tips of ears are normally removed at the cannery, whereas corn borers remain in the kernels and cobs.

Control

The corn earworm is unpredictable to deal with. Once a corn field becomes infested, the protective husk on ears makes the insect difficult to detect or control. If growers find the infestation early enough, a series of insecticide treatments is recommended to keep damage to a minimum. The insect is considered to be one of the most destructive attacking sweet corn. When insecticide treatments are required, growers should follow the local spray recommendations. Spray the insecticide around the silks and repeat applications at 3-day intervals. In the home garden, use a compressed-air hand sprayer and in large commercial plantings, use a high-clearance power sprayer set to cover the silks. Some corn varieties are more susceptible than others to the corn earworm; those that have long ears with tight husks extending beyond the tips are more resistant to infestation. In areas where the corn earworm is most common, growers should consult their agricultural representative for information on the less susceptible varieties in their area.

Natural control results from cannibalism by larvae, from parasites of eggs and larvae, and from a number of predaceous insects and birds.

Corn leaf aphid

The corn leaf aphid is a soft-bodied, greenish blue insect which infests the tassels and upper leaves of corn. It is found wherever corn is grown in Eastern Canada, although it is most prevalent in southwestern Ontario. It does not overwinter in Canada, but is carried in each year by air currents from the south where crops are more advanced.

Infestations begin when the corn plant is in the whorl stage. All forms are females which, on becoming adults, can produce living young without mating. Because of this, and the fact that the whorl area provides a moist, nutritious, protected area during the main reproductive period, this aphid is capable of very rapid buildup. By the time the tassel emerges, the aphids may be so numerous that they cover the whole upper part of the plant. Plants may be dwarfed, whorl leaves desiccated, and yields greatly reduced. In some instances plants will be barren (ears devoid of kernels). The aphids also secrete a very sticky substance called honeydew in which a black fungus may develop. If this condition is severe, pollination may be decreased or prevented. Corn earworm moths are often attracted to the honeydew. This aphid is also a carrier of maize dwarf mosaic, a serious virus disease found in southern Quebec and southwestern Ontario.

Control

Corn hybrids vary greatly in susceptibility to aphid attack and growers who plant resistant hybrids usually have no problem. Growers of susceptible hybrids may find that late-planted corn is more subject to infestation than corn that is planted early; also, aphid populations are usually higher in dry years than in wet years. Work at Harrow in southwestern Ontario has shown that the amount of rainfall that occurs during 2–3 weeks preceding pollination is of great importance. Plants already suffering from moisture stress during a drought had a much greater yield loss from an equivalent population of aphids than when moisture was adequate. Chemical control is rarely justified for most growers. In fact, many are unaware of aphid infestations until the tassels are exposed. Although numerous plants may have moderate to severe infestations and the plants are glistening with honeydew, control is seldom feasible at this time because a major portion of the injury has already occurred. In addition, spraying of plants at this time will destroy predators which feed on aphids and other insects. However, growers of commercial seed crops might benefit from chemical control, particularly if they have planted late and the plants are under moisture stress before pollination. The whorls of plants in several areas of a field should be opened to determine if there is a pre-pollination buildup of aphids. An insecticide with systemic properties would be more effective than a contact insecticide at this stage of plant development.

Billbugs

Several species of billbugs (snout beetles) may injure corn plants. The adults eat the leaves, making small holes in the stems of very young plants and puncturing the developing leaves while they are still curled in the heart of the plant. These punctures are revealed when the leaves expand, as a series of transverse rows of holes of similar size and shape. Sometimes the leaves fall or twist into a curl and interfere with the growth of later leaves. There could be an excessive production of suckers or sprouts if punctures are made low down on the stalks. The larvae or grubs attack the roots and they may cause serious injury by tunneling up into the stems. The degree of injury depends on billbug population density and plant size. Normally, corn plants are able to continue growing in spite of billbug attacks. Heavy feeding may kill seedlings, but light feeding causes sprouting or suckering and development of stunted, deformed, unproductive plants.

Control

Do not plant corn on land that has not been cultivated for a number of years. If it is necessary to use such an area, be sure to apply a recommended insecticide before planting. Corn should not follow corn in a rotation if there is a billbug problem. Good drainage, fall plowing, and clean cultivation are recommended practices.

Chinch bug

The chinch bug has been found in all the eastern provinces, but it is of concern only occasionally in extreme southwestern Ontario, particularly in Essex County.

The adults overwinter in any plant shelter available, but are most often found in grass sod and weedy areas along fencerows, roadsides, and pasturelands. They are about 5 mm long, with a black body and whitish wings. The wings have a triangular black patch at the center of their outer edges which gives the insect a mottled appearance. In spring the bugs leave their winter quarters and lay eggs on small grains, usually winter wheat in southwestern Ontario. The young, or nymphs, are reddish.

In Canada, chinch bugs are usually not numerous enough to cause much damage to wheat. However, at harvest or shortly before, when the crop begins to ripen and dry out, the bugs fly or crawl to corn if it is growing nearby. If you live in an area where there are chinch bugs, watch for these insects. Carefully examine corn in the rows next to ripening wheat. If they are present, you will probably see the black-and-white adults and the reddish nymphs first on the ground at the base of corn plants. Later they climb the plants and suck the plant juice from the stems.

Control

If you find chinch bugs in corn, consult your local entomologists or extension specialists immediately. Generally, control is limited to treating

the rows nearest to the wheat with an insecticide. You can reduce the probability of having a problem with chinch bugs by keeping fencerows and surrounding fields free from weeds.

Grasshoppers

Grasshoppers are seldom a serious pest of corn in Eastern Canada. Occasionally in Ontario, but more particularly in Quebec, they cause serious damage to plants growing at the margins of fields. Grasshoppers may attack these plants by eating the tassel, tips of the ears, and portions of the leaves, so that the plants have a ragged appearance. They seldom attack corn before the plants are 50 cm high.

Most species of grasshoppers overwinter in the egg stage. The eggs are laid in the soil in packet-like masses, usually in uncultivated areas such as field margins, pastures, and roadsides. Hatching occurs in late spring and early summer.

Control

Grasshopper infestations seldom originate in corn fields. Maintain weed-free borders and fencerows. If young grasshoppers are numerous in early summer, keep grass cut along field margins and spray with an insecticide. If the corn field is beside an old pasture, spray the pasture immediately after planting.

Corn flea beetle

Occasionally the corn flea beetle causes damage near Lake Erie. It attacks all types of corn, but does most damage to early-planted canning corn. The beetle is small and black, and jumps quickly when disturbed. In early summer, it eats the leaves, making tiny holes but more important, it is the carrier of bacterial wilt of corn, commonly called Stewart's disease. The disease can seriously hinder growth of small plants and it often kills them; it is especially severe after a mild winter and a cool, wet spring. The disease is carried in the alimentary tract of the beetles, which spread it throughout fields where they feed. The beetles spend the winter in sheltered places near old corn fields. Feeding usually begins when the plants have two well-developed leaves. The larvae of this beetle feed on the roots of the host plants.

Control

Growers in the Lake Erie district should watch for this insect, especially if the preceding winter has been mild. If you notice small black beetles on very young corn, treat the plants immediately with a recommended insecticide.

Some varieties of sweet corn, such as North Star and Northern Belle, are very susceptible to Stewart's disease, and if you grow these varieties, you should spray them once, just after the plants emerge. Since flea beetles also develop on many weeds, keeping fields and field borders as free of them as possible is of value in control.

Cereal leaf beetle

The cereal leaf beetle, a European pest of grain crops, was first found in the United States in 1962 and in Canada in 1967. It can be a serious pest of cereal crops and a minor pest of corn.

The adult beetle is about 5 mm long. The wing covers and head are metallic blue black, and the legs and prothorax (the part of the body behind the head) are reddish orange. The larva is slightly larger than the adult and looks like a black slug. Actually, the larva is yellowish brown, but it is usually covered by a moist glob of excrement.

Both adults and larvae damage plants by chewing out long strips of tissue between the leaf veins. When the damage is severe the leaves turn whitish, and the field looks as if it has been hit by frost.

The adults overwinter in trash, under loose tree bark, in old corn stalks, and in other places affording suitable shelter. Warm spring weather makes the beetles active and they begin feeding on wild grasses. Later they fly to nearby fields of winter wheat and, still later, to fields of emerging oats, where they feed and lay their eggs. When corn appears, late-emerging beetles may attack this crop, although they prefer other cereals. On corn, the tiny eggs are laid on the underside of the leaves, whereas on other cereals they will be found on the upper surfaces. The eggs are yellow at first, darkening to almost black before hatching about 5 days later. The larvae feed for about 10 days, then move into the soil to pupate, emerging as beetles in 2–3 weeks. The new beetles feed for a short period, then go into summer diapause until autumn. Later they seek sheltered places to pass the winter. One generation occurs per year.

Control

An effective parasite of the cereal leaf beetle is now established throughout Ontario and no chemical controls have been needed since 1977. There is also a quarantine in effect to prevent the spread of this insect to other areas of Canada. The quarantine regulations are shown in the *Ontario Field Crop Recommendations*. If this pest is of concern on your farm, consult the local agricultural office for advice.

Sap beetles

At least one species of sap beetle attacks corn. It has no approved common name, although it is often referred to as the four-spotted sap beetle and the picnic beetle. The adult beetle is blackish and has two yellowish red spots on each upper wing cover.

The adult hibernates under debris, in old tree stumps, in the top 2.5 cm of soil where there is grass sod or tall weeds, and possibly in other protected places. When the biology of this insect was studied at Harrow, Ont., no overwintering forms were found in the spring in soil that had been cultivated in the previous fall. Egg deposition starts in early May and the larvae develop on decomposing plant matter. The main source of plant matter in southwestern Ontario was found to be ears of corn that were missed by harvesting

machinery the previous fall, often as a result of damage to stalks and shanks by the European corn borer. Newly emerged adults begin to appear from late June to early August, depending on the area. They are attracted to over-ripe fruit such as raspberries, melons, and cracked tomatoes, both in the field and at roadside stands. There is only one generation per year.

In sweet corn, sap beetles enter the tip of the ear and feed on the developing kernels. Although they are generally considered to be secondary invaders and infest ears that have already been damaged by the corn earworm, European corn borer, or birds, there is evidence that they will sometimes attack previously undamaged ears. Varieties with a short or loose husk are probably more susceptible. In an outbreak year, sap beetles can do a great deal of damage if conditions are favorable.

Control

In sweet corn, a regular spray program for the European corn borer and corn earworm will help reduce sap beetle infestations. The growing of tight-husked varieties might also be helpful in reducing insect and bird damage. In grain corn, yields are seldom reduced and contamination is not a problem.

COMMON AND SCIENTIFIC NAMES OF INSECTS

Armyworm	<i>Pseudaletia unipuncta</i> (Haworth)
Billbugs	<i>Sphenophorus</i> spp.
Black cutworm	<i>Agrotis ipsilon</i> (Hufnagel)
Cereal leaf beetle	<i>Oulema melanopus</i> (Linnaeus)
Chinch bug	<i>Blissus leucopterus leucopterus</i> (Say)
Corn earworm	<i>Heliothis zea</i> (Boddie)
Corn flea beetle	<i>Chaetocnema pulicaria</i> Melsheimer
Corn leaf aphid	<i>Rhopalosiphum maidis</i> (Fitch)
Corn rootworms	<i>Diabrotica</i> spp.
Cutworms	Noctuidae
Dingy cutworm	<i>Feltia jaculifera</i> (Guenée)
European corn borer	<i>Ostrinia nubilalis</i> (Hübner)
Fall armyworm	<i>Spodoptera frugiperda</i> (J. E. Smith)
Glassy cutworm	<i>Crymodes devastator</i> (Brace)
Grasshoppers	Acrididae
Northern corn rootworm	<i>Diabrotica longicornis barberi</i> Smith & Lawrence
Potato stem borer	<i>Hydraecia micacea</i> (Esper)
Sap beetle	<i>Glischrochilus quadrisignatus</i> (Say)
Seedcorn maggot	<i>Delia platura</i> (Meigen)
Southern corn rootworm	<i>Diabrotica undecimpunctata howardi</i> Barber
Spotted cutworm	<i>Amathes c-nigrum</i> (Linnaeus)
Variegated cutworm	<i>Peridroma saucia</i> (Hübner)
Western corn rootworm	<i>Diabrotica virgifera virgifera</i> Le Conte
White grubs (June beetles)	<i>Phyllophaga</i> spp.
Wireworms (click beetles)	Elateridae

